An Overview of Effect of Splitter Blades on Centrifugal Pump Performance

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ABSTRACT:

In turbomachinery design like pumps and compressors impeller is crucial part. The performance of the pump is depending upon the design of an impeller. It includes various parameters like blade inlet & outlet angle, impeller inlet & outlet diameter and number of blades. Increasing thenumber of blades increases the head of the pumpbut it causes a decrease in efficiency. The decrease in efficiency is due to the blockage of the fluid due to reduced area and increased friction inside the casing. Hence impeller with splitter blades can be used which reduces the clogging at impeller inlet. This addition of the splitter blades leads to increase the performance of the pump. As the splitter blade length increases; the flow rate and power increases, the efficiency decrease. As well as hydraulic performances are improved, pressure fluctuations are reduced, and operating range is extended.

In this paper overview of various works are done. This paper tries to give an idea about the previous researches & their finding about study of effect of splitter blades on the centrifugal pump performance.

Key words- splitter blades, centrifugal pump performance, impeller.

I. INTRODUCTION-

The design of centrifugal pumps still remains very empirical. During the last few years, the design and performance analyses of turbomachinery have experienced great progress due to the joint evolution of computer power and the accuracy of numerical methods. It is found that a numerical approach using a design analysis tool like CFD is of recent origin and the whole field flow analysis of the complex flow in a centrifugal fan has been the state of the art in the domain. Centrifugal pump is system which undergoes various operating conditions. Impeller is the important part of this system. Performance of the pump can varied by varying the various geometries of the pump such as casing geometry, blade inlet and outlet angle, inlet and outlet diameter of the impeller, thickness of the blade, number of blades. The various techniques also implemented for the performance improvement of the pump like impeller trimming, use of splitter blades. The geometry of the splitters is the same as the main blades and it is circumferentially positioned half way between the main blades.

By considering all above facts, this paper tries to cover literature which deals with an effect of splitter blades on the centrifugal pump performance. In this paper overview of various works are done.

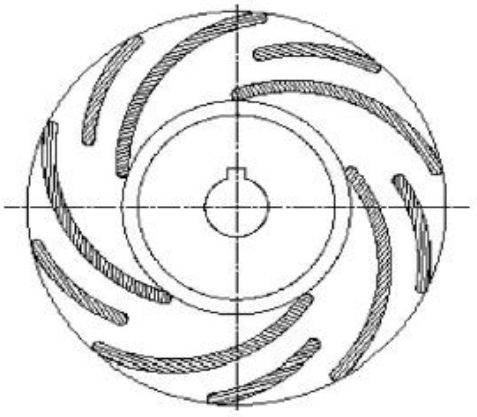

Figure 1 Impeller with splitter blades

This paper tries to give an idea about the previous researches & their finding about study of effect of splitter blades on centrifugal pump performance.

II. INFLUENCE OF SPLITTER BLADES ON THE FLOW FIELD OF A CENTRIFUGAL PUMP

G. Kergourlay [1] studied on ENSIVAL-MORET MP 250.200.400 pump impeller. the impeller-volute casing interaction was studied with the help of sliding mesh method. The flow morphology analysis showed that, when adding splitter blades to the impeller, the impeller periphery velocities and pressures become more homogeneous. The splittered impeller head is approximately 10–15% higher than the original impeller whatever the flow rate is.

The head is increased because there is increase in the impeller slip factor but this decreases the efficiency. This also leads to reduce the pressure fluctuation, hence decreases the vibration acceleration

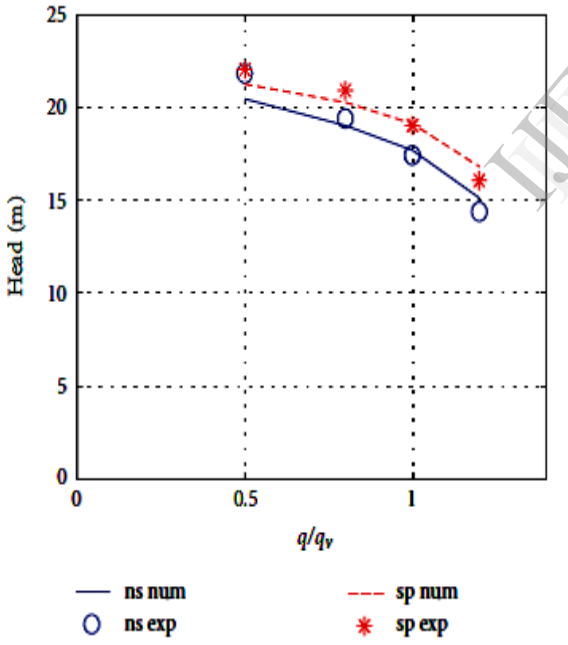

Figure 2 Head against Flow rate with and without splitter blades

The head is evaluated at various flow rates: 50%, 80%, 100%, and 120% of the flow rate at the best efficiency point (BEP). The pressure fluctuations are measured at four locations at the BEP using dynamic pressure sensors.

III. PREDICTION OF HEAD, EFFICIENCY, AND POWER CHARACTERISTICS IN A SEMI-OPEN IMPELLER

Mustafa Golcu [2] used an Artificial Neural Network to predict the effect of splitter blades in semi open impeller on centrifugal pump performance. The values of head, efficiency, and effective power were estimated in a semi-open impeller with splitter blades in ratio of 3/6 and 5/6 of the main blade length at the best efficiency point. ANNs were used for modeling of a semi-open impeller with and without splitter blades Neuron is the fundamental processing element of a neural network.

This ANN model consists of one hidden layer of log-sigmoid neurons followed by an output layer of one linear neuron. Linear neurons are those which have a linear transfer function

A computer program was performed under Matlab software. Training of the network was performed using Levenberg-Marquardt (LM) and Scaled conjugate gradient (SCG) feed-forward back propagation algorithms. LM and SCG algorithms have been used to predict of the head, efficiency, and power of a semi-open impeller with splitter blades using different flow rate and splitter blade lengths.

The effects of lengths of splitter blades in ratio of 3/6 and 5/6 of the main blade length on head, efficiency and effective power is as shown in table 1.

Flow rate and non-dimensional splitter blade length have been used as the input layer; head, efficiency, and effective power have also been used as the output layer. The algorithm with 9 neuron shows the increased performance.

The selected ANN model with the single hidden. layer used in our study is shown in Figure 3

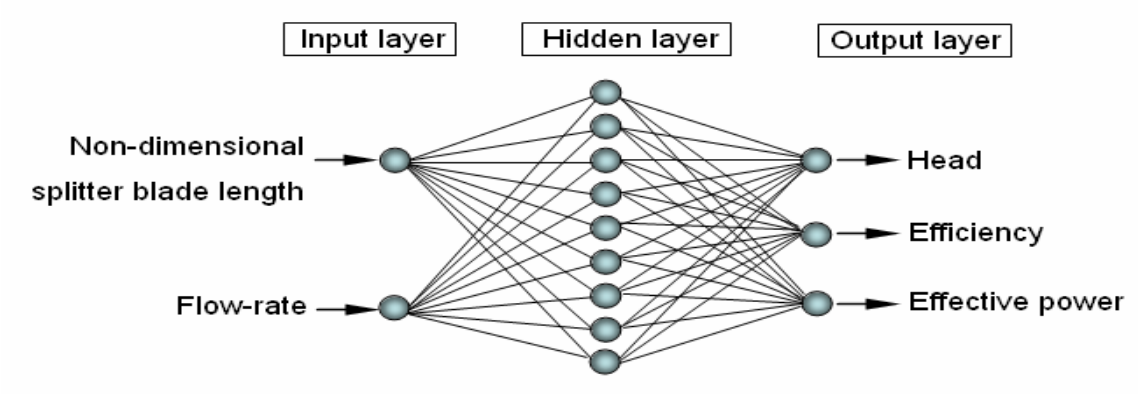

Figure 3. Artificial neural network (ANN) model of the semi-open impeller with splitter blade.

b.e.p.	H_m (m)	η (%)	P_e (kW)
Without splitter blade	33.86	39.80	5.56
$\bar{L} = 3/6$	34.48	38.90	5.80
$\bar{L} = 5/6$	34.69	38.47	5.90

Where Q = 400Lpm, rated point.

Table 1. Performances of splitter blades

IV. IMPELLER TREATMENT USING SPLITTER VANES

Madhwesh N. [3] examined the effect of splitter vanes to various geometrical locations on the impeller. He designed the impellers with the splitter vanes at different locations.

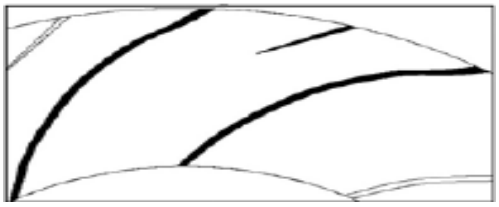

Figure 4. splitter vanes at mid span of trailing edge

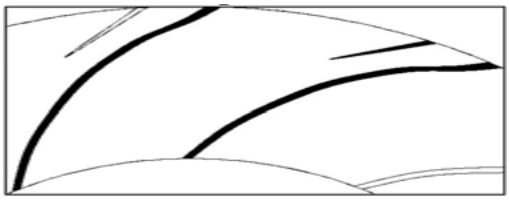

Figure 5. splitter vanes at trailing edge at pressure side of impeller

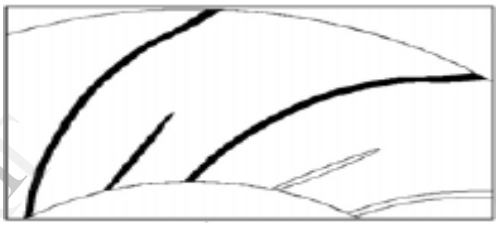

Figure 6. splitter vanes at mid span of leading edge

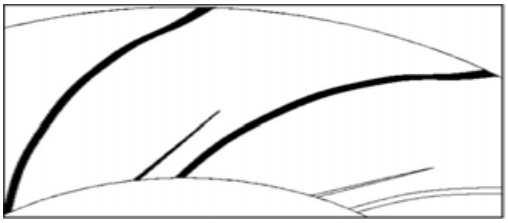

Figure 7. splitter vanes at leading edge at pressure side of impeller

This modeling was analyzed using sliding mesh method in CFD.

Splitter vanes provided at the impeller trailing edge (shown in figure 4.) produce significantly lower static pressure which gives poor performance.

Splitter vanes provided at the impeller leading edge (shown in figure 6.) provide relatively large static pressure recovery of the fan gives good performance.

V. INFLUENCE OF SPLITTER BLADES ON THE TOTAL FLOW FIELD OF A LOW-SPECIFIC CENTRIFUGAL PUMP

Zhang Jinfeng [4] designed two impellers with and without splitter blades of IS 50-32-160, a low-specific speed centrifugal pump model. The numerical method is used to study effect of splitter blades on the performance of low-specific centrifugal pump. The splitter blades causes the increase in head by 4% - 15%. The efficiency at large discharge are improved and keeps higher at a wider range.

The pumping head increases along with increase in discharge.

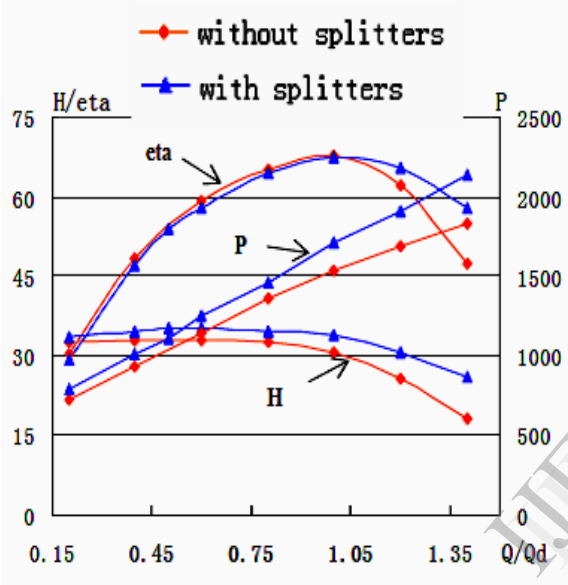

Figure 6. Performance curves

Splitter blades gives the smoother pressure and velocity distribution at impeller exit and volute inlet. It also reduces the pressure fluctuation.

VI. STUDY ON THE ACOUSTIC CHARACTERISTICS OF A CENTRIFUGAL IMPELLER WITH A SPLITTER

Wan-Ho Jeon [5] calculated the effects of splitter vanes that are attached to an original impeller on acoustic signature. He used A Discrete Vortex Method (DVM) to describe the flow-field of the centrifugal fan. Lowson's equation is also used to predict the acoustic far-field pressure. the splitter modifies the acoustic characteristics of the centrifugal impeller He designed the impellers with different number of blades. In the splitter impeller, the peak level at BPF is reduced by about 10 dB and the 2nd harmonic frequency is raised about 3dB.

VII. CONCLUSION

This paper presents an overview of the recent developments in the implementation of splitter blades in centrifugal pumps. The following conclusions can be drawn from the literature review

1. Implementation of splitter blades reduces the clogging of fluid at inlet of impeller hence improves the performance of pump
2. Splitter blades reduces the pressure fluctuation hence decreases vibration and noise.
3. Splitter blades increase the head of the pump for same power input.

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